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ABSTRACT

This examination of the Air Force instructional development model begins by presenting the history of instructional development in the Air Force and providing reasons for the adoption of the instructional systems development (ISD) process. Each step of the ISD process is explained, and supporting forms and diagrams are provided. The steps considered include system requirement analysis; development of job performance requirements; development of objectives and tests; planning, development and validation of instruction, including selection of instructional methods, media, and materials; and evaluation. Steps and methods peculiar to the military or the Air Force are emphasized, and problems encountered by the Air Force in the implementation of this process are discussed. Four figures and three tables are included. (Author/EW)

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Chapter 38

Instructional System Development in the United Stated Air Force

Hilton D. Goldman

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The ID model has probably received its greatest development in both richness of detail and breadth of application within the military. Presented here is a detailed description of the model as it has been developed by the U.S. Air Force. Also presented is a history of this effect, its successes and its problems. Much information and many techniques which can be exported intact to other settings are included.

THE EVOLUTION OF AIR FORCE TRAINING CONCEPTS

By directive, the Air Force is committed to using an instructional system development (ISD) process for developing new instruction and for revising existing instruction. The implementation of the ISD process represented another step in an evolutionary process that began in the Fall of 1943 (when the Air Force was still part of the Army). Till then, instruction had been accomplished largely through the use of lectures and demonstrations. Then Lieutenant General Walter R. Weaver, Commander of the Technical Training Command, ordered all chairs removed from the classrooms, prohibited the use of classroom lectures, and banned the use of written examinations. General Weaver believed in practical training. The students were to learn by doing. The instructor provided demonstrations to precede the student performance, and gave over-the-shoulder guidance as the students performed. In the earlier stages of their training, the students worked with part-task trainers, cut-aways, and models. By the final stage, they were working with actual equipment in real or simulated job conditions.

In 1950, the Air Force Training Command adopted the use of the term "developmental approach" to instruction, and made its practice a command-wide policy. "Developmental approach" referred to student-centered instruction in which the student learned through controlled self-activity. This approach started with that which the student already knew at his ability level and lead through successive steps of reason and progress to the desired result. The developmental approach was essentially problem-oriented; the problems, which the student was encouraged to solve, were posed through the learning activities. The problems were centered around experiences which would give the student the opportunity to use mental and motor abilities and to develop the skills necessary to do the job for which he was being prepared.

The next step in the evolution of Air Force instruction came in September 1961 when Headquarters USAF directed the implementation of programmed learning. An ordery transition was to occur in a series of phases leading from research through development to operational application. Programmed learning was defined as "efficient learning which results from employing programmed instructional techniques and materials to help students meet specific learning objectives." It was "a complete system" that included all instructional materials, equipment, and educational media,

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designed and validated to attain instructional objectives. The following concepts are basic to programmed learning as conceived by the Air Force:

Behaviorally analyzed. The task to be learned is subjected to a detailed analysis, and training objectives are explicitly specified.

Controlled student responding. By forcing the student to make specific overt responses, her/his behavior is shaped step by step until s/he achieves a mastery of the subject.

Immediate confirmation. Following her/his responses, the student is provided with knowledge of results. Making a correct response, and being confirmed in her/his response, strengthens the probability that s/he will respond appropriately in a similar situation later.

Optimum Step Size. Instructional material is broken into "small" segments to which the student can respond correctly. They should not be so small as to be boring, nor so large as to be confusing.

Controlled pacing. Normally it is not necessary for all students to move at the same pace, but they must arrive at the same place.

Validation. Instruction should be tested to see if it successfully teaches representatives of the target population before it is released for use in operational courses.

Student-Centered. All of the previous characteristics point to the student. What does the student need to know? Get the student actively involved, not just the instructor. Let the student know how well s/he is progressing all along the way. Present material in portions commensurate with her/his learning ability. Within reason, let her/him learn at a rate appropriate to her/his ability.

The Air Training Command conducted a 1½ year investigation to determine the feasibility of an extensive application of this educational technique. During this period, about 350 people were trained to develop programmed instructional materials (doubling the number of trained instructional programmers in the United States). They produced approximately 100 experimental programmed-instructional packages to replace conventionally-taught topics that had each taken from two to thirty hours to teach. These packages involved a wide range of subject-matter and applications. When the experimental packages were field tested, the results were encouraging: though the developers were working with limited resources and experiences, these packages produced an averaged reduction of 35% in training time and an average gain of 15% in achievement.

One of the things that was learned from this experience was that independent study need not be reserved for just the superior students. Another is that the self-pacing of a short segment of a longer course does not result in a time savings, unless that segment is at the end of the course. The other benefits from programmed instruction also are much greater if the complete course is programmed than they are if only one segment of the course is programmed, or if each segment is programmed independently.

By now, thinking was in terms of instructional system. The Air Force approach to instructional systems development was hammered out at a workshop held 1-5 June, 1964. What emerged represented the consensus of the thinking of many people, including Robert Corrigan, Bill Deterline, Roger Kaufman, David Klaus, Robert Mager, Sylvia Mayer, Sue Markle, Col. Gabriel Ofiesh, Maj. Marvin Roever, and Leonard Silvern. They were leaders in programmed instruction and human engineering,[1] and they drew heavily from both fields to produce their theoretical model for instructional systems development. The ISD process delineated by the 1964 workshop has since been polished and refined, but basically it is still the same.

The workshop members also drew up a plan for implementing this model. They chose to create a number of instructional systems development teams, manned primarily by instructional programmers. The teams would be the means for developing the instructional systems.

The first major instructional system developed by one of these teams was the Administrative Specialist Course. That system became operational in August, 1965. Before systemization, this was a 330-hour course for the training of apprentice-level Air Force clerk-typists. The students were taught typing (at least 35 words per minute), Air Force publication, correspondence procedures, and filing. The systemization process showed that self-paced instruction was better suited to this course than the group-paced instruction that had been used. Following systemization, the average student needed less than 210 hours to complete the course, and some students finished in as few as 96 hours. Based upon extensive field testing which was conducted prior to its acceptance, at least 90% of the graduates of the instructional system were able to successfully perform at least 90% of the training objectives. To fully appreciate this accomplishment, you should know that the conventional version of the course was highly effective on its own right, and was steeped in tradition. This made it even more difficult to introduce changes that involved a break with that tradition.

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[1] Human engineering means the engineering of equipment for human use. It is concerned with assigning to each - to man and to machine - the function each performs best, but always considering that man and machine must operate as an integrated unit. "Good" human engineering means that the designer has made optimal use of both. The human engineering design problem is not how to design a machine, but how to design a system.

Table 38-1. Evolution of Air Force Approach to Instruction.

Characteristics	Learn by Doing	Developmental Approach to Training	Programmed Learning	Instructional System Development
Student-centered Instruction	X	X	X	X
Training experiences determined by job requirements	X	X	X	X
"Job requirements" determined by expert opinion	X	X	X	
Job requirements determined by survey of operating activities				X
Training defined by objectives		X	X	X
Objectives stated in behavioral terms			X	X
Common understanding of objectives by students and instructors		X	X	X
Objective measurement		X	X	X
Provision for quality control		X	X	X
Start training where the student is		X	X	X
Validate instructional materials			X	X

The evolution in the Air Force approach to instruction is summarized in Table 38-1.

THE AIR FORCE INSTRUCTIONAL SYSTEMS DEVELOPMENT PROCESS: INTRODUCTION

Instructional systems development (ISD) is a deliberate and orderly process for planning and developing instructional programs in order to insure that personnel are taught the knowledge, skills, and attitudes essential for performing a job successfully. We emphasize that ISD is a **process.** The instructional system which is developed as a result of applying that process is the product.

These are some of the concepts that underlie the USAF ISD process:

-- The instruction to be provided is determined by the skills, knowledge, and attitudes that are needed to do the job. Air Force instruction must equip people to do their jobs. More instruction than that is wasteful: less can cause big problems. So, the designer must know what the job requires.

-- Instruction is provided only for those job requirements which the students have not already mastered. It is inefficient to "teach" them what they already know or can do. So the designer must know what relevant knowledge and abilities the students entering training bring with them.

-- The instruction the students need must be identified in specific terms which will communicate the same meaning to all who are involved in that instruction: the curriculum planner, the instructor, the student, and the job supervisor who will receive the graduating student. To assure such communication, the Air Force requires that instructional objectives be stated in terms of observable behaviors. (More precisely: the behavior, the conditions under which it is to be performed, and the standards for performance.)

-- Students are tested on their ability to meet the criteria defined by the objectives, rather than on how well they do as compared to other students. This is a logical consequence of the policy that the only reason for training in the Air Force is to equip people to do their jobs.

-- The instruction is **student**-centered. Objectives are stated in terms of student performance, rather than in terms of what the instructor will do. Instruction also is described in terms of student activity.

-- Both the students and the instructor know what must be learned, and when the students have learned it. They know what must be learned because they are all privy to the objectives. Test items are devised to measure the attainment of each objective, and these items must test for the same behaviors that are spelled out in the objectives. So there are no surprises, no "tricky" tests.

-- If the student doesn't learn, it is the fault of the system design - rather than of the students - and the system must be reworked until it is effective.

-- Instruction must be provided in the most cost-effective way possible. That is, we seek to provide **quality training at the right time at the least cost.**

THE AIR FORCE INSTRUCTIONAL DEVELOPMENT PROCESS: THE MODEL FOR ISD

In the briefest terms, the Air Force ISD process requires the following actions:

1. Determine precisely what the skilled performer does when doing the job, how well s/he must do it, and under what conditions.

2. Determine if instruction (in this chapter, **instruction** can be read **both as education and as training**) is needed and, if so, determine what instruction to give the untrained personnel so that they can do their jobs well.

3. Express these instructional needs as specific behavioral objectives. Devise a test item for each objective so that you can know if and when the students achieve the objectives.

4. Design instructional procedures and materials to help the students achieve the objectives. Validate these procedures and materials by having students try them to be sure they are effective. The measure of success is their ability to accomplish the test items. If the students fail the test items, redesign the instruction until it works.

5. Conduct and evaluate the instruction; and later, evaluate the graduates on their ability to do their jobs.

A simplified five-step model summarizes the process and shows the inter-relationships involved.

1. Symbolically, Figure 38-1 shows that each succeeding step of the model builds upon information which was developed in the preceding step(s). However, this does not mean that the developer must **complete** each step before starting on the next. Realistically, s/he could be involved with actions in several steps simultaneously.

2. The feedback and interaction arrows symbolize the fact that changes in one part of the model can affect other parts of the model. An example would be the evaluation of the graduates. Evaluation of their ability to do the job (step 5) might show that they cannot properly perform part of the job. This might be a result of improperly designed instruction - or it might be that the job has changed since the instruction was implemented. In the first case, the developer may need to change the instruction (step 4). In the later case, s/he may need to return to step 1 and make a partial or even a complete re-analysis of the job requirements.

3. The outer box around the model is labeled "constraints." It symbolizes the real limitations that the instructional programmer must deal with: the preferred training medium may cost too much; there may not be enough time to do a thorough analysis of systems requirements; there may be no opportunity to try out (validate) the

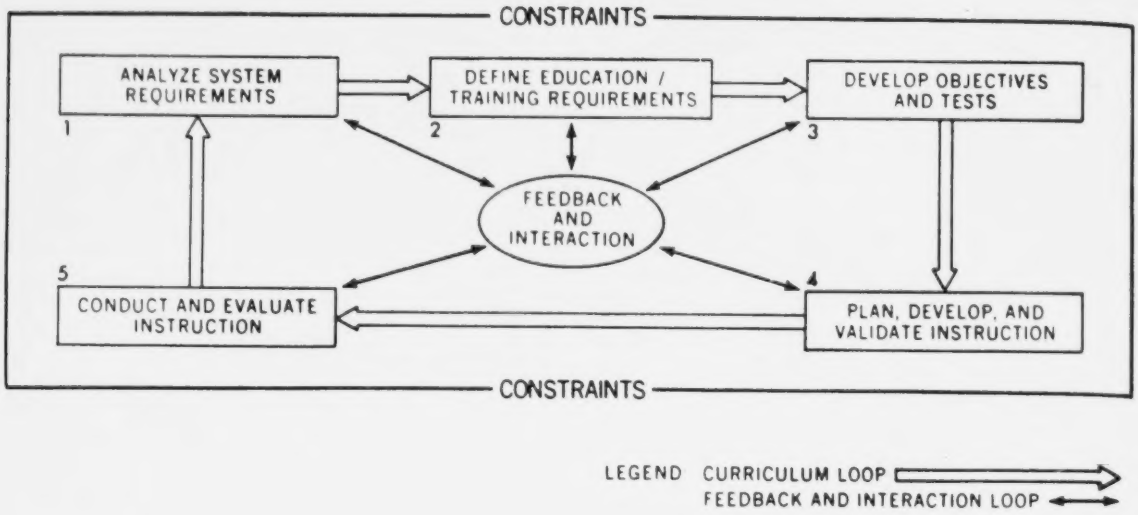

Figure 38-1. Model for instructional system development.

instructional materials before they are used, and so on. These constraints must be considered in the design of the system. The goal of the instructional system designer is to build an instructional system which is the best possible one considering all of the alternatives, where "best" is defined to be the most cost-effective way possible. The need to deal with valid constraints is not license to bypass major parts of the systems-development process for frivolous reasons. compromises, and the reason(s) for them, **must be documented decisions.** This is necessary because ISD is an iterative process, and it may be desirable to make changes in the implemented system once a constraint has been removed. Unless there is documentation, it is quite possible that the reason things are as they are may be forgotten.

4. The significance of the fact that the steps of the model form a loop is that the developer can enter the model at any step in the process. Thus, for ongoing instruction, s/he might start the process as a result of a graduate evaluation (step 5) which indicated some problems with the instruction. A change in training policy would cause her/him to enter the process at step 2. A change in job performance requirements would require entering the process at step 1.

Documentation is an important part of the systems development process. Though the Air Force publications on ISD show formats to be used for the documentation of the process, these are suggested rather than directed. The basic ISD process is applicable to the whole spectrum of Air Force instruction, from heavily performance-oriented technical training to heavily cognitively-oriented college-type education. Therefore the specific documentation needs will vary. So the Air Force allows for flexibility in the amount of documentation to be provided and in the way it is to be formatted. Documentation is a means to an end - not an end in itself. Every bit of documentation put together during the development of the system should serve a useful purpose. The system designer should document in whatever way is most useful to her/him. How much documentation is enough? Obviously, a course that is to instruct many students, or one in which the cost of instruction is high, should be given more careful development and documentation than a course designed to teach just a few students a relatively noncritical subject. In any case, s/he should document in enough detail to provide a "data trail" so that others may know the basis upon which the major decisions in the design of the system were made. Unless such a data trail exists, it is impossible to profit from past mistakes, or to refine the system when recycling through the model sometime in the future. More specifically, the data trail should provide answers to the following questions:

1. What was the basis for deciding that instruction was needed?
2. What basic assumptions or major constraints applied? (Possible examples: "Train for assignment only;" "There was a maximum of one month to develop instruction;" "Because of fuel limitations, there could be only four training flights per student;" etc.)
3. What was the basis for deciding what tasks required instruction?
4. What was the basis for deciding what type of instruction to use (i.e., formal course, OJT, correspondence course, performance aid, etc.)?
5. What was the basis for the major instructional-methods decision(s)?

6. What was the basis for the major instructional-media decision(s)?

7. What was the basis for the instructional sequence that was selected?

As a minimum, the following documents should be included:

1. An ISD application plan to ensure management control of ISD actions.
2. A listing of essential job tasks.
3. A training standard[2] (if appropriate).
4. A list of objectives.
5. Test items to measure the objectives.
6. A Plan of Instruction/Syllabus/Course Outline (if appropriate).
7. A course chart (if appropriate).
8. The validation data for the instructional materials.
9. The feedback data from evaluation.

How long should these data be kept? Keep it as long as it is needed for reference. Generally, this would mean that the developer would keep it as long as the instructional system was operational. Of course, portions of the data might be replaced as they are superseded.

The ISD process is begun when someone identifies a need. A few examples:

-- "Supervisors of recent graduates of course _____ complain that the graduates are ineffective in locating electrical troubles in the _____ system."

-- "Next year we'll be getting a new test stand, and our maintenance men don't know how to use it."

-- "The shop should be able to overhaul four engines a day, but they have been averaging only three."

-- "During the past six months our personal injury rate has been going up."

-- "They just don't have the right attitude!"

After determining what the job involves (Step 1), the developer must decide if the need can be corrected by instruction. If it cannot, there is no need to proceed further with the ISD process. If instruction is needed, s/he must determine what instruction to provide (Step 2). Before s/he chooses instruction through a formal course as the way to meet the need, s/he should consider other, less costly, alternatives (such as assigning or reassigning qualified personnel, the use of performance aids, on-the-job training, etc.). If s/he determines that a formal course is appropriate, there still are several options: to use an existing course, to modify an existing course, or to develop a new course.

When the developer begins to apply the ISD process, **s/he should not set out to "ISD a course" or courses.** If there is a valid need for one or more courses, the need will be revealed as s/he proceeds through Steps 1 and 2 of the process. If s/he prejudges the need for a course before s/he has the data upon which to base that decision, s/he may devise an unneeded course. Management often makes this mistake, deciding that the establishment of a course is a cost-effective solution to a problem, and directing the establishment of that course, before it has been determined that there is a valid instructional problem. Often, they will compound the problem by setting the course-length. Thus, "We need a one-week course in shop safety because the accident rate in our machine shops has tripled in the last six months." What they should say is "The accident rate in our machine shops has tripled in the past six months. Make an analysis to determine what must be done to correct this situation. If training is a part of the solution, prepare an ISD plan for my review and approval."

Description of the Process: Analyze Systems Requirements (Step 1)

The first step in the ISD process is to analyze the requirements of the operational system. This analysis is critical because all other steps in the ISD model depend upon information provided by this analysis. The system will involve people to support it, to operate it, to manage it. The analysis must identify the different human roles in the system and what kinds of performance each will require. The analysis must also answer the questions, What will it take to get people qualified to do these jobs? and, Will this include a need to provide instruction?

System analysis involves the collection of data about the system and its operation. Analysis of this data should produce a description of the system in terms of:

a. Mission or purpose
b. Functions or performances required to satisfy the mission.
c. Major subsystems and components used to structure the system.
d. Equipment or materials required to support the system.
e. Established concepts, policies, or procedures for system operation, maintenance, or use.
f. Effects of environmental and psychological factors on system operation and maintenance.
g. The functional responsibilities of people.

As data about the operational system are gathered, they must be analyzed in order to identify the human tasks required to operate, maintain, control, and support the system. The product of this effort is a list of all job tasks, the equipment or materials involved with each task, the condi-

[2] A training standard is a control document which specifies the skills and knowledges, and the proficiency in each, that the graduate is to possess.

tions under which the task must be done, and the standards of performance which must be met. These are the job performance requirements. For later use, the developer will need data on how often each task is done, what the safety requirements are, how critical the task is, and how difficult it is to learn to perform it. S/he can make determinations by observing the personnel in the work environment, by interviewing or surveying supervisors and subject-matter specialists, and by studying the applicable speciality description, training standard, related training documents, design documents, technical orders, and other documents which provide information on the system.

There are many possible sources of data which can be tapped dealing with new equipment. The contractor is a major source of data.

For on-going programs that are to be systemized, the best source of information is the experienced person on the job. This may be the worker or the supervisor. Several methods are available for gathering this information; each has strong and weak points:

1. **Occupational survey.** The occupational survey is the Air Force procedure for the analysis of Air Force occupations which produce duty and task lists. Occupational surveys obtain, from a sample of job-holders, background information about them and data about the duties and tasks they perform. This information is put together and statistically analyzed by computer. The results are presented in the form of an Occupational Survey Report. This report includes:

-- A list of all of the tasks performed.

-- The percent of the members who perform each task.

-- The relative difficulty of learning each task.

-- The training priority (a numerical index that will show the tasks' priority for resident training).

The USAF Occupational Measurement Center is an organization that specializes in conducting these occupational surveys for the Air Force.

2. **Questionnaire.** The questionnaire is a way of gathering job information through a mail survey. It asks job-holders to give certain background information and to describe the job in their own words. When describing their job, the individuals are asked to identify the duties and tasks they perform and to list the materials, tools, and/or equipment they use. Supervisors may be asked to verify responses before the job-holders return the questionnaires.

3. **Checklist.** This survey method is different from the questionnaire method in that the checklist contains a list of duties and tasks believed to describe the specialty or a position in a specialty. The duties and tasks listed are based upon information gathered from specialty descriptions, instructional standards, job proficiency guides, and procedural or technical publications. In this type of survey, the individual is asked to identify, usually by means of a (✓), the duties and tasks s/he performs. The results of the survey are used to update the duty/task list for the specialty or position. It is possible to administer the checklist to a large group of job incumbents, thus making job-requirements data from widely representative sample populations rapidly and economically available.

4. **Individual interviews.** In using this method for collecting job-requirements data, the developer selects a number of representative workers to be interviewed. S/he asks those selected what duties and tasks they perform. Each person is interviewed, usually away from the work situation, and the information is recorded on standardized forms. When all of the interviews are completed, the information is consolidated into a single job-performance requirements list.

5. **Observation interviews.** This method is like the individual interview except that it takes place at the worksite. While the worker performs duties and tasks, the person gathering the information asks questions about the work being done and records the information. As a result, the information obtained should be more specific, more complete, and more accurate than that obtained by other methods. It is important to select for observation those personnel who are at the skill-level that the instruction is to produce. Thus, watching a highly experienced hand at work may give a wrong picture of what is to be expected of a newly graduated worker.

NOTE: The job observation will identify what the workers **do.** The questionnaire or individual interview will identify what they **say they do.** The questionnaire or interview data must be used with caution because workers tend to say they do what they think they should do.

If the developer is dealing with attitudes or with knowledge that is not task knowledge--a category that applies primarily, but not solely, to education courses and to programs for changing attitudes--s/he may have to apply **goal analysis** or **content analysis.**

1. **Goal analysis.** Knowledges and attitudes are in the mind. They cannot be seen. The problem, then, is that the techniques previously described (occupational survey, questionnaire, checklist, or interview) are usually limited to what is observable and so will not directly and reliably show the knowledge and attitudes necessary to do the job. But there is an alternative: goal analysis. All educational programs are based upon broad goals. (A goal, as the term is used here, is a statement of educational purpose). For example, job supervisors may say that the workers must "appreciate the importance of ground safety in performing their jobs." This could become a goal for an instructional program. Before the developer can use such a goal statement in the instructional design process, it must be changed into behaviors that can be seen, and that would be accepted by the supervisors as very likely indications that the

workers do have this appreciation. It is necessary to define these indicator behaviors and to use them as possible evidence that the knowledge or attitudes exist. Some behaviors that might be accepted as indicators that the workers do "appreciate the importance of ground safety in performing their jobs" are:

-- Follows published safety procedures and regulations even when not supervised.
-- Keeps work area clean.
-- Reports safety hazards.
-- Talks to others about their unsafe practices.
-- Gives suggestions for improving safety.

These indicator-behaviors could be treated as job performance requirements.

2. **Content analysis.** Some courses are intended to teach a body of knowledge (for example, astrophysics, aptitude and achievement measurement, social psychology). The goal is to "cover the subject," rather than to teach the student specific job applications, because the jobs are so many and varied. In this case, too, the occupational surveys, questionnaires, checklists, or interviews described earlier in this chapter may not provide much guidance as to what to include in the instruction. The next-best thing is to accept, as a goal, that the instruction should cover all of the subject-matter identified in the title. If this is done, the subject-matter experts will decide what the goals should be. These goals would substitute for the job performance requirements, and the developer would use these as the starting point for instructional design.

Job-performance requirements form the base upon which to design instruction and the frame of reference for evaluating the instruction. In addition, the developer uses job performance requirements to determine the number of personnel required from each Air Force specialty; the interaction between system personnel; work location; and the equipment, tools, or materials required to do the job. This information makes it possible for her/him to:

1. Determine what kind of instruction, and how much of it, is needed. Decisions about the amount and kind of instruction have implications for the amount and kind of instructional resources which will be needed (Figure 38-2).

2. Because of operation, equipment or policy changes in the time between the determination of the job performance requirements and the use of the completed instructional system, the instructional system could be outdated by the time

JOB PERFORMANCE REQUIREMENT:

Using the correct checklist, the pilot performs a walk-around inspection of the T-38 aircraft before flying it.

Task: performs a walk-around inspection.

Conditions: using the correct checklist, and a T-38 airplane....

Quality Standards: "correctly" is implied.

IMPLICATIONS FOR INSTRUCTION THAT WILL SUPPORT THIS JOB PERFORMANCE REQUIREMENT:

- The trainee will *not* have to memorize any information contained in the checklist.
- The trainee must learn to associate the nomenclature of the checklist with the components of the aircraft.
- The trainee must learn to discriminate between "correct" and "faulty" for each checklist item. The amount of drill needed will vary from item to item depending on the criticality to flight safety.

IMPLICATIONS FOR RESOURCES NEEDED TO SUPPORT THE INSTRUCTION

- The trainee should have a copy of the checklist.
- A T-38 aircraft should be available for the trainee. It may be possible to reduce the requirement for aircraft by using photographs or slides.

Figure 38-2. Job performance requirements.

it is completed. To avoid this, probable changes in the job should be included in the data gathered.

Before instructional system planning and development can start, the developer must make a thorough analysis of the system, career area, or speciality to which the system graduates will be assigned. To do this requires that s/he use all of the sources of information available to her/him. The data obtained from the various sources should be compared in order to ensure accurate identification and a good understanding of the requirements. The system analysis must also give information needed in order to decide if instruction is required, or to develop or revise instruction. A list of the duties and tasks to be performed is the basis for ISD.

Description of the Process: Define Requirements (Step 2)

The developer analyzes the Job-Performance-Requirements Data; the process of determining what instruction, and how much of it, is needed, starts with an analysis of the job performance requirements. The developer compares the job-performance-requirements list that has been prepared with what is known about the ability of the people who will have to to the job. This comparison should show whther or not there is a need for instruction. If instruction is needed, the comparison will also show for which tasks or portions of tasks it is needed.

If the workers can do the job properly, but are not doing so, the developer should take a hard look at the working conditions. The cause may be: lack of motivation; human relations problems; pressures for overly high productivity; inefficiently organized work area; insufficient light; uncomfortable temperature; etc.

For workers already on the job, the developer's analysis should show which job performance requirements they can't meet. These will be the job-performance requirements for which instruction will be needed; instruction will not be needed for the others.

Even for workers who don't know how to do the job, some of the job-performance requirements may be so simple that instruction is not needed. The developer analyzes those job-performance requirements which will require instruction in order to identify the associated skills and knowledge.

The developer next selects job tasks requiring instruction. These are some of the factors s/he should consider in identifying those tasks for which instruction is needed in order to support the job-performance requirements: the number of people who will do the task; the criticality of the task ("criticality" refers to the relative importance of a task to mission success); the frequency of performance; learning difficulty; the time interval between the training and the initial performance; and the extent of the trainees' prior, relevant experience. Although each of these factors should be considered separately, the developer must also consider them collectively. Thus, a task that is rarely performed might still warrant instruction if it is a critical task (for example, mouth-to-mouth resuscitation).

Another decision to be made during this step of the process is how to supply personnel who are qualified to meet the job-performance requirements. Several alternatives should be considered by the developer before undertaking the design of new courses.

1. It may not be necessary to give instruction in order to provide qualified personnel. They may be available as a result of the phaseout of another system, or as a result of surpluses in allied career areas. Another alternative is to recruit personnel who can do the job.

2. On-the-job training is a systematic use of self-study and of the craftsman-apprentice principle. OJT may be quite suitable for developing job proficiency and is often used with, or as a continuation of, instruction received in a formal course.

3. Education or training requirements can often be met through the use of existing courses that are available to the Air Force. These courses may be conducted by the Air Force, or provided to the Air Force by other government agencies, by industry, or by civilian educational institutions.

4. When it has been determined that an instructional need cannot be met through the existing course, the developer should consider modifying that course.

5. The home-study package should be used in those situations in which it is more practical to bring the instruction to the students than the students to the instruction. The home-study approach is a proven idea, and new developments in instructional technology have extended the possibilities of what can be included in such instructional packages. Slides with simple handviewers and audiotape cassettes make the use of multimedia packages quite feasible. Programmed instructional techniques can make the instruction student-centered and individualized. Simple responder devices can give prompt feedback to the student going through the instruction. Through use of the ISD process, instructional packages can be produced with the confidence that they will do what they are intended to do.

6. A job-performance aid or set of aids may give all the instruction necessary in some situations, and avoid the need for formal instruction. Job-performance aids can assume many forms. The plate on a gas heater that gives instructions for lighting the heater is a simple job-performance aid. The Decision-Logic Table is another form of job-performance aid that is fairly common.

When these methods for providing the task situation with personnel who can meet the job-performance requirements have been considered and rejected, the developer is left with the decision to develop an instructional package in the

form of a formal course of instruction.

There are several criteria and constraints affecting the selection of methods for supplying qualified personnel which the developer must weigh in deciding which of the above methods to use:

1. How many trained people will be needed and when will they be needed?
2. What is the probable range of relevant aptitudes, experiences, and skills among the segment of the population which would be used as trainees, if training is selected as the method? (This information can affect course content, course length, and equipment and facilities needed. It also helps in deciding if existing courses can be used.)
3. How much time will be available to develop and start instruction? If there isn't enough lead-time, the developer may have to purchase instruction, or hire trained people to do the job, until there is time to develop Air Force instruction or until the instructional requirement ceases to exist. (If instruction is to be bought, whatever information has been gathered relating to Steps 1 and 2 of the ISD process will provide useful guidance in specifying what the contractor is to provide.)
4. How many qualified instructors will be needed to develop and conduct the instruction? If instructors are not available, 9 to 12 months must be allowed for obtaining the personnel and qualifying them as instructors. If the prospective instructors must also become technically qualified in the subject-area to be taught, even more time must be allowed in order to obtain proficient instructors. The developer must also consider the availability of the personnel needed to conduct the detailed planning and development of the instructional system.
5. Will equipment and facilities for conducting the instruction be available? Decisions about the instructional methods to use may be influenced by the need for, and the availability of, equipment and facilities. Although a detailed instructional design has not yet been produced, the developer usually already can identify the requirements for facilities and major items of equipment. Getting these resources usually requires lead-time for their development and installation. So, first, the practicality of modifying the equipment and facilities that are already available should be considered.
6. What would be the programmed student load? This is the number of students that must be in a course at any one time in order to satisfy the need for trained personnel. For example, when considering the use of an existing course, the developer should check on that course's capability for handling more students. If it is already operating at its maximum capacity, an increased student load will create a need for more instructors, equipment, or facilities.
7. What will it cost? This factor is presented last since almost all the other considerations have an impact upon it. The developer should evaluate each of the possible means for providing qualified personnel in terms of its economy, effectiveness, and timeliness for meeting needs. The cost factor is quite important when comparing the advantages and/or disadvantages of bringing the student to the instructional activity as opposed to taking the instruction to the student. Cost must always be considered in context with quality of training. The developer's **goal must always be to develop and to give quality training at the least cost.**

The developer cannot determine the total resources needed until Step 3 and 4 of the ISD model have been completed. However, because the planning for many of these resources must be accomplished many months before they are needed, the developer may have to identify some of the resource needs before Steps 3 and 4 have been completed. These will include:

a. System-peculiar or unique equipment.
b. Facility needs (if the construction or modification of existing structures will be required).
c. Personnel.
d. Funding.

At this stage, the developer will have determined the job performance requirements. S/he can now identify, at the major-task level, the instruction to be provided. For this purpose the Air Force uses, as the primary course-control document, an instructional standard. These standards are specialized publications used to standardize and control instruction. They are also the means for coordination between those who are responsible for instruction and the organizations for whom the instruction is conducted. Such coordination helps to ensure that the instruction is designed to meet the client organization's needs. Within the instructional standards, by means of task and knowledge statements, the instruction needed to qualify personnel to do the job is listed. These listings are the quantitative requirements to be met by the instructional system. Instructional standards are also qualitative. They show the level of proficiency to be developed for each task or knowledge.

Description of the Process: Develop Objectives and Tests (Step 3)

Developing Objectives

The learning of a physical skill requires experience in performing that skill. Mental habits are also learned through practice. Even attitudes are developed or modified as a person reacts emotionally to a stimulus. This means that for learning to take place, the learner must be actively involved in the learning situation.

Learning Cannot Be Directly Observed

But it can be inferred on the basis of how the learner behaves following instruction compared

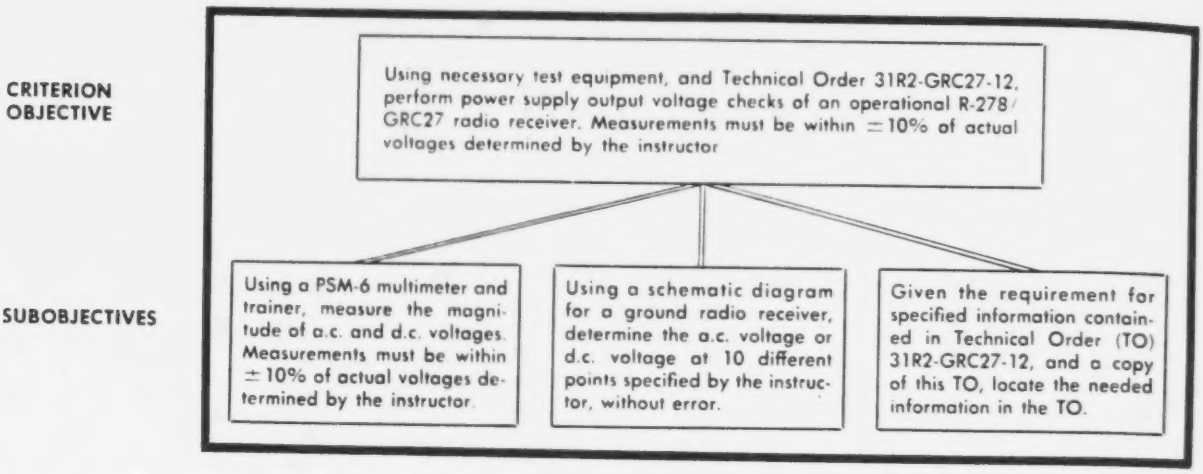
CRITERION OBJECTIVE
Using necessary test equipment, and Technical Order 31R2-GRC27-12, perform power supply output voltage checks of an operational R-278/GRC27 radio receiver. Measurements must be within ±10% of actual voltages determined by the instructor
SUBOBJECTIVES
Using a PSM-6 multimeter and trainer, measure the magnitude of a.c. and d.c. voltages. Measurements must be within ±10% of actual voltages determined by the instructor.
Using a schematic diagram for a ground radio receiver, determine the a.c. voltage or d.c. voltage at 10 different points specified by the instructor, without error.
Given the requirement for specified information contained in Technical Order (TO) 31R2-GRC27-12, and a copy of this TO, locate the needed information in the TO.

Figure 38-3. Levels of objectives.

with the way in which s/he behaved before instruction. The person who has learned something is somehow different from the same person before the learning took place. The person's behavior is different. Since instruction should shape the desired behavior, the objectives of that instruction should describe the behavior to be shaped. Also, observable behavior is what must be used to judge whether or not the instructional objectives have been achieved.

An objective is a precise statement which answers the question, what must the student do in order to show that s/he has learned what s/he was expected to learn? It specifies a behavior to be shown. For the statement to be understood in the same way by all who work with it, it must also include the minimum standard of performance or proficiency expected, and the conditions under which that proficiency is to be shown.

Levels of Objectives

The developer can specify objectives for basis skills and knowledge, and also for more complex skills which represent combinations of these basics. Together, they form a "pyramid of objectives" (Figure 38-3).
Each of the sub-objectives in Figure 38-3 could, in turn, be further broken down.

Source of Objectives

The developer should draw the instructional objectives from the education or training requirements which were identified in Step 2. Thus, the objectives in Figure 38-3 were established to support the following job performance requirement, which was determined to require training: Perform power output voltage checks of an operational R-278/GRC27 radio receiver, using technical orders and necessary test equipment.

Identification of Supporting knowledge and Skills

Once the developer has written the objectives, s/he can identify the knowledge and skills which support each objective. S/he examines each objective in order to discover the intermediate steps (sub-objectives) in the learning process which must be reached before the student can successfully accomplish the objective. Some of these sub-objectives involve skills which must be mastered before an objective can be met. Others pertain to specific concepts, principles and facts which must be learned. The developer can identify the required knowledge and skills through a behavioral analysis.

Identifying the skills and knowledge necessary to meet an objective is not a simple process. Because skills can be seen and knowledge cannot (and therefore must be inferred), it is more difficult to identify precisely what knowledge is needed to do a job-task than to identify the skills required. The only knowledge which should be included in an instructional program is that which is needed to do a job-task or tasks (either manipulative or mental).

The following list of questions will help to identify job and task behaviors for which knowledge may be needed. The questions do not provide a means for determining what specific knowledge is needed in order to perform a task. Rather, they are intended to help the developer in the identification of those job activities in which knowledge is likely to be of use to the student.

1. Is a knowledge of nomenclature and location of parts required?
2. Are safety precautions involved?

3. Is the interpretation of symbols or signals necessary?
4. Do calculations have to be made?
5. Are the techniques of problem-solving, diagnosing, and trouble-shooting required?
6. Does the task require the anticipation of later conditions based upon earlier conditions?
7. Is planning needed in order to perform the task?
8. Is the selection of strategies involved?
9. Must the task be performed in accordance with briefing instructions?
10. Is the use of tools and general test equipment required?
11. Is knowledge of the "why" of a procedure essential?

Developing Tests

Defining objectives is only a part of step 3. The other part is to develop a means of testing by which to measure the attainment of these objectives. These are called criterion tests because they test against the criteria for a successful performance which were identified in the objectives. With a criterion-referenced test, students are rated on their ability to achieve the objectives. How others score on the test has no bearing upon an individual's grade. (This is in contrast to the norm-referenced test, in which a student is graded on how well s/he does in comparison with other students.)

Each criterion test item should be based solely upon the requirements specified in the objective for which it is to be a measure. In fact, the wording in both the test item and the objective may be the same. In an automotive course, for example, one may find the following criterial objective: "Using an electrical test set, adjust the voltage regulator until the volt-meter indicates 14 volts, within a tolerance of $\pm$ .2 volt." In this case, the objective itself is a good test item; in other cases, some rephrasing may be necessary. In any case, a test item should require students to respond only as specified in the objective, under established conditions, at or above [3] the minimum level of acceptable performance. The objective cited above requires the students to do the task. The corresponding [4] test item should require the same performance by the students--not merely have them to state the procedures that are involved in the adjustment of the voltage regulator.

When the developer has established the objectives and constructed the criterial test items to measure them, the objectives and test items must be approved by the proper authority. After that, the instruction to enable the students to reach that target must be designed. The objectives clearly define the target, and the criterial test items provide a means for determining whether or not the instruction accomplishes what it should.

The developer will also have to construct test items to measure whether the students have learned the supporting skills and knowledge which contribute to their ability to perform the objectives. As with the criterial test items, these diagnostic test items should measure precisely what is to be taught - no more, no less.

During validation, the instructional system designer can use diagnostic test items to predict success, to identify problem areas, and to adjust instruction for unanticipated individual differences. Once the instruction is validated, it would seem that there would be no further need for the diagnostic tests. For if the student can pass a criterial test item, this should prove that s/he has mastered the component skills and knowledge. However, if the instructional testing of a validated program is limited to criterial test items, there can be a delay before it is found that a student has not learned. Judicious use of diagnostic tests is appropriate, and will help in avoiding this problem. But the extensive use of diagnostic tests during instruction, after that instruction has been validated, is expensive in terms of time and effort and is unnecessary.

The survey test is a most important part of the instructional design process. Survey tests are used to determine what the prospective students (the target population) already know or can do before receiving instruction. Survey tests should not be confused with pretests, though their design may be similar. The administration of the survey test while the instructional system is being developed will provide valuable clues for conducting this development. The results of the survey test will aid in deciding for which objectives instruction is needed and which objectives can be dropped because the student population has already learned them. For example, if you find that nearly all of a sample of prospective students can do a particular task or that they know a certain piece of information, then this skill or knowledge may not have to be taught. But, if few can show mastery of a particular skill or knowledge, then more than likely you should include the corresponding objectives in the instruction. Before deciding to drop instruction because many of the students already have the skills and (or) knowledge, consider such factors as:

-- How can instruction be economically provided to the few who do need it?

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[3] Minimum level of acceptable performance does not imply weak or inadequate performance. The minimum acceptable performance may be perfection.

[4] Performance is not limited to physical manipulation, such as writing or welding. There also is performance when one adds numbers, makes a judgment, etc. Performances of the latter kind can only be observed indirectly, as when the sum of the numbers, or the judgment, is written or spoken.

-- Are there seasonal variations in the aptitudes of the prospective students?

-- How difficult is the task to learn?

-- How critical is the task to mission success?

The survey tests include items selected from the criterial tests. In the optimal case, the ability to meet all criterial objectives should be measured. In addition, the test should survey related abilities of the target population, such as grade level in reading, ability to make mathematical calculations which are involved in job tasks, etc.

Pretests are used when individualized instruction is used. The pretest should measure the individual student's ability to meet each criterial objective. It is given to each student before instruction. How well the student does on the pretest determines what instruction that student is given.

In summary, it can be said that objectives represent the specific intent of instruction in terms of behavioral end-products based upon job requirements. Sub-objectives establish the intermediate skills and knowledge necessary to satisfy the requirements of the criterial objectives. In and of themselves, objectives have little significance if tests are not developed which will measure the behaviors specified by the objectives, or if these are not used to validate the success of the instructional system; these are the two functions of criterial tests. When practical, survey tests should be used in determining which objectives should be kept in the instructional system. Also, pretests should be prepared at this time if it is anticipated that an individualized instructional design will be chosen in the next step. Once these activities are completed, the developer can plan, develop, and validate instruction.

Description of the Process: Plan, Develop, and Validate Instruction (Step 4)

To perform this step requires the careful planning of instruction to satisfy the objectives. This involves the placing of the learning activities or exercises in such an order as to produce the required learning in the shortest time. It also involves the placing of the learning activities or exercises in such an order as to produce the required learning in the shortest time. It also involves the selection and planning of those instructional methods, media, and equipment which most effectively support the learning objectives. These planning activities will provide the developer with the information needed in order to identify resource needs. This step also includes the development and validation of the instructional materials. The validation process certifies that the instructional materials and the instructional methodology combine in such a way as to teach the students what they need to know. Validation is conducted through a series of tryouts with students in which the criterial test items are used as the measuring device. Any portion of the instruction which fails validation during these tryouts must be changed until it succeeds.

Planning and Developing Instruction

Learning is defined as a change in the behavior of students as a result of their experience. In accomplishing steps 1 and 2 of the ISD process, both the desired behavior (job performance requirements) and the current capabilities of the target population were identified. The difference between the two is the learning deficiency that must be made up through instruction. This instructional requirement was then described through a set of objectives (Step 3). Now that it is known what behaviors must be shaped, the developer must plan the means for shaping them. This planning should employ the following concepts in order to effectively manage the learning process.

1. **Active student participation.** The instructional designer and the instructor can only arrange for learning to take place. It is the students who do the learning. They learn by doing, thinking and feeling--by answering questions, discussing, computing, manipulating, putting ideas together, etc.--within the context of an appropriate specific activity. Until the students have applied in an appropriate way what they were taught, it is risky to assume that they have learned. Learning is an individual process in which students gain knowledge and skills and shape attitudes through their own activities, experiences, and motivation.

2. **Confirmation (knowledge of results).** As the students participate, through various types of responding, it is helpful to them (that is, makes for more efficient learning) to know how well they are doing. Confirmation consists of informing the students whether or not their responses are correct.[5] This kind of feedback may also provide a valuable source of motivation.

3. **Planned pacing.** The rate at which students go through an instructional sequence is referred to as pacing. There are several ways to pace students' progress. Traditionally, instruction has been presented in a group-paced fashion; that is, all of the students in the class were given the same instruction at the same time. There are some learning situations in which group-paced instruction is appropriate, and others in which the instruction would be self-paced.

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[5] Reinforcement is often associated with confirmation, but the two terms are not synonymous. Reinforcement has a special effect on behavior. It makes that behavior more likely to occur again when the same stimulus is present. Confirmation may be a means for providing reinforcement, but it is not the only means.

Not all students can reach the required level of performance of a task in the same amount of time. Because of varying ability, background and motivation, some will learn faster than others. Ideally, then, the instructional designer would plan for each student to go through the instruction at a pace best suited to that student. Where it is possible to use self-paced instruction, a savings in instructional time will usually result. Another benefit is that each student reaches the specified level of proficiency.

It may not be practical to use only group-pacing or only self-pacing for a whole course. Fortunately, many instructional systems can employ a combination. using group-pacing where necessary and providing self-paced instruction when possible.

There are several techniques for providing planned pacing. Proficiency Advancement is a technique which can be used to advance students who have prior knowledge, who have practical experience, or who are exceptionally fast learners. Students demonstrate their proficiency by passing the criterial test for a particular instructional sequence. Students are advanced through each sequence for which they have passed the criterial test.

By having two, three, or four alternate tracks of instruction, it is possible to choose the track best suited to each student's needs and abilities. Usually, the placement of students in these tracks is determined by the use of a pretest. Multiple tracks could also be used when it is known that, following graduation, the students will have different assignments, and it is known which students will get which assignments. In this situation, all students receive that portion of the instruction which is common to their needs. Then they are divided into groups, and each group receives that instruction which is appropriate to its specific assignment.

In modular scheduling, the instructional system is divided into units of instruction called modules. Each module covers one or more objectives. Students are pretested and counseled to determine their particular instructional needs. Pretest results and information gained through counseling are analyzed in order to determine the specific modules needed by each student. Then an individual program is designed for each student. Structuring a course in this way will eliminate from each student's schedule that instruction which is not needed and can reduce average course length.

Self-paced instruction involving programmed texts and other programmed instructional materials can be used in such a way as to let each student progress through the instruction at her/his own pace. These programs can be designed either to involve the assistance of an instructor or to be used independently. Materials that do not require any instructor assistance can be used for out-of-class study.

Learner-controlled instruction has been used successfully in situations in which students are highly motivated, with one of the desired ends of instruction being that the students develop self-reliance and initiative. In learner-controlled instruction, the students are given the set of behaviorally-stated objectives and a test item for each objective so that they can determine when they have met the objectives. They are told what learning resources are available and where they are. The students are free to use any part, all or none of the resource materials as they deem necessary. When they feel ready, they go to the instructor to take the unit test.

Instructional Increments - Sequence and Size

Since the objectives provide the framework for the structure of the system, the sequencing of the order in which the objectives are taught is a very important part of system development. The sequence of instruction can greatly affect the motivation of a student. Sequencing can show relationships which can be used to make instruction more meaningful. Obviously, the more meaningful the content, the easier it is to learn. Proper sequencing avoids unneccessary duplication in course content. It also prevents gaps in instruction and makes sure that the development of a skill is orderly; i.e., that prerequisite knowledge and skills have been learned before the introduction of more advanced subject-matter or the performance of more complex tasks. The developer can sequence course content in any of several ways: job performance order, psychological order (from the simple to the complex, the known to the unknown), logical order, or a combination of these.

Another important concern in ISD is the optimal size for each increment of instruction. We use the term "optimal" to indicate that exact amount of instruction which is necessary in order to produce the desired results. The natural tendency is to "play it safe" and provide more instruction than is necessary. This causes the training to cost more than it necessarily must, and may cause boredom, especially among the more able students. The best approach is to begin with a minimal amount of instruction, and to rely upon the validation of the instructional elements to show where more instruction is needed. This process, plus feedback obtained from the evaluation of instruction already validated, is used to determine the optimal amount of instruction. If more instruction is provided in the beginning than is necessary, there will be no good indication of what can be eliminated.

Selecting Instructional Methods

While we must discuss the selection of instructional methods and the selection of instructional media separately in this chapter, methods and media cannot really be considered independently. The only meaningful question is: Which method-and-media combinations are the most

effective for given instructional purposes?

After the instructional objectives have been specified, the essential knowledge, skills, and attitudes to be learned in order to meet each objective must be identified. Once these have been identified, the instructional methods and media to be used in teaching them can be chosen. One way to do this is to relate the behaviors involved to one or more of the types of learning. (An instructional objective can involve more than one type of learning.) The types of learning, with examples of each, have been listed in Table 38-2. The first six types of learning listed in this table have to do with knowledges; these have been placed in a sequence, beginning with the least complex ("association"). The next higher type of learning is the forming of chains. Chains are simply two or more associations linked together. Each of the higher types of learning involves all of the lower types. Some instructional methods and media are more effective than others in facilitating a particular type of learning. So, once the type of learning involved has been identified, an appropriate instructional method and medium can be chosen.

In choosing the instructional method(s) to use to teach a particular skill, knowledge or attitude, the developer should consider the type of learning involved (Table 38-2). Probably, this will still leave several alternatives. Student differences and the availability of time and resources will determine which alternative is most appropriate.

Selecting Instructional Media

We use the term **instructional media** to refer to the different means used to provide information to the student. Examples would include a classroom instructor, a book, a flight simulator, a computer terminal, pre-narrated slides, actual items of equipment, or television. Properly selected instructional media provide some of the physical circumstances required for proper initial learning and for later practice of the knowledge, skill, or attitude to be gained. The necessary information for helping students learn can be provided through a wide variety of instructional media, and through various combinations of these media. A properly designed procedure or strategy for meeting a training objective must perform three functions: present information, provide practice, and provide feedback to the student. Many different instructional media can be used in performing each of these functions with equal effectiveness. As long as the courseware (such as motion picture films, video programs, programmed instruction booklets, or pre-narrated slides) and the training exercises provide all the information that students need, at a rate at which they can learn--so long as this situation prevails, it does not make any instructional difference which medium is used. The choice between media of the same instructional effectiveness is then based upon other considerations, such as cost, maintainability, etc.

The design of student exercises, performances, or practice items should be based upon what has been determined to be necessary for the student to do in order to assure that the satisfactory transfer from the learning situation to the job will occur. This student activity may range from a verbal response in a classroom, or filling in the blank in a programmed instruction booklet, to operating a Minutemen Missile Procedures Trainer or the C-5 Flight Simulator. Many tasks should be learned under conditions resembling those to be found on the job, with equipment identical with that found on the job. However, high cost, safety, and limited resources often prevent the use of actual equipment in a job-like environment. Too, a well-designed instructional program may use techniques which make the instructional environment physically unlike the job environment in order to make the instruction more effective. Such techniques include:

-- Using more feedback during training than is normally provided on the job (giving the students more knowledge of the results of their activities than they would receive on the job).

-- Providing many more crises, conflicts, equipment breakdowns, or emergencies at shorter time intervals than is normal to the job environment.

-- Reducing the normal length of time taken by events so that there will be more training time left for the students to practice the critical parts of the tasks involved.

-- Providing small amounts of practice on selected aspects of similar tasks rather than practicing each of these tasks separately, thus increasing the effective use of limited practice time.

-- Providing aids, prompts, or guidance during learning. Sources of prompting information include aids that are a part of the training task or job task, job aids (including checklists, picture guides, or other specially designed aids for training), a classroom or field instructor, a classmate (peer), a mediated program (such as an automated apprenticeship training approach, handouts, and other resources. Some actual equipment is not suitable to use in training because it isn't designed to take as much abuse as it would receive from students. The problem of stripped threads in "remove-and-replace" training exercises using actual equipment is an example of this design problem in training.

A first step in media selection is to decide which level of resemblance to the job the active learning environment should display. Generally, it is best to have the instructional situation as similar as possible to the job situation. But there are exceptions. Sometimes in the early stages of instruction, resemblance to the job is not desirable. As an example, consider the student who is learning to recognize different forms of bacteria. S/he could be started off with a microscope and actual stained slides--which is the job environment.

Table 38-2. Types of learning.

TYPE	PERFORMANCES RELATED TO DIFFERENT TYPES OF LEARNING
Forming Associations	Involves associating, naming, or responding to a specific input (stimulus). The person associates the response with a specific input only. The response may be vocal, subvocal (say-it-to-yourself), written, or motor. **Examples:** Naming objects you see; stopping at a red traffic light.
Forming Chains	Involves recalling sequences of actions or procedures which must be recalled in a **specific order.** In a chain the response to one input becomes the input to the next response. May involve chains of verbal responses or chains of motor responses. **Examples:** Verbal chain: reciting a memorized poem; stating a rule. Motor chain: tying a shoelace; starting an aircraft engine.
Making Discriminations	Involves making different responses to the various members of a particular class; being able to distinguish among input information sources and/or types and then to respond appropriately to each. **Example:** Recognizing the differences among similar gauges on an instrument panel and reacting appropriately with a vocal, subvocal, written, or motor response.
Making Classifications	Involves responding in a single way to all members of a particular class of observable or abstract events. This involves recognizing the essential similarity among a class of objects, people, events or abstractions, and recognizing the differences which separate those objects, people, events, or abstractions which are not members of the class. **Example:** Classifying aircraft as being tactical, fighter, transport, etc.
Using Rules	Involves applying rules to a given situation or condition by responding to a class of inputs with a class of actions. A rule states the particular relationship between two or more simpler concepts. It is helpful to think of rules as "if-then" statements. **Example:** If a metal rod is heated, then it will expand.
Problem Solving	Involves comparing previously learned rules to create a higher order rule. **Example:** Troubleshooting a malfunction in an aircraft radar system. (Many rules are involved in tracking down the specific malfunction.)
Performing Skilled Motor Acts	Involves manipulative tasks which require the smooth, integrated use of eyes and hands. Often this skill entails variations in the actions, where one action will be dependent on the results of other actions. **Examples:** Making a sensitive adjustment that requires precise timing; shooting a rifle accurately; driving a golf ball.
Exhibiting Desirable Attitudes and Opinions	Involves enhancing an individual's preference for a particular point of view, idea, or course of action. **Examples:** A willingness to obey traffic rules in the absence of authority; exercising safety practices on the job; desiring to master the skills being taught.

But that would make the instruction unnecessarily difficult because this medium contains much that is distracting. An alternative is to start the student's instruction with slides showing an artist's representation of the bacteria, using idealized forms and colors, and with no stain debris. As the student advances in her/his training, a transition is gradually made in the slides toward realistic job conditions, and in the **final** stage of instruction s/he uses the microscope and actual stained slides.

Table 38-3 can be used as an aid in making preliminary media decisions. This table shows the types of learning (from Table 38-2) in relation to representative instructional media. The instructional developer should be able to relate any instructional objective to one or more of the types of learning. The table can be used to rule out inappropriate options, so that the developer can make realistic trade-offs in the selection of instructional media for the training systems.

There are other factors, too, that should be considered in selecting media:

-- Equipment for instruction should be easy to set up and to operate.

-- When individualized instruction is the instructional method, the media used must permit the student to control the rate at which instruction is presented.

-- Spoken words and moving pictures are transient. If the capability to repeat them is required for effective individualized instruction, then the media devices selected should have that capability.

-- The number of students to be trained and the location of the students (all at one site, or at many locations across the country) will affect the quantity of media, materials, and resources needed.

Two important questions remain. Though they involve non-instructional considerations, the answers to these questions will affect the choice of media: (1) Who (what organization) will develop, produce, and revise the courseware that is needed? Do they have the facilities and the qualified personnel to do the job? If not, what new facilities, overhead costs and personnel will be needed? (2) How will the media devices that are selected (the hardware) be obtained and maintained? What is needed must be matched with what can be procured. That involves both the availability of the hardware and the length of time it would take to procure it. Since different instructional media can be equally effective in presenting the selected information, these two questions may become decisive factors in making the final choice.

In deciding which media to use, the overall consideration must be, what will permit accomplishing the mission with maximum cost effectiveness? Each of the media-selection considerations already discussed have a bearing upon this decision.

Determining Resource Requirements and Costs

During this step, the developer must also identify total resource requirements. Figure 38-4 lists the types of resources and cost factors that must be considered in developing the instructional system.

Developing Instructional Materials

Another important activity involved in this step of the model is that of developing the most effective instructional materials to support each teaching-learning activity. These materials include such items as texts, student study-guides

TYPES OF RESOURCES AND COST FACTORS

RESOURCES	COST FACTORS
• EQUIPMENT Instructional Support	• DEVELOPMENT
• FACILITIES Classrooms Laboratories Special-Purpose	• INVESTMENT Equipment Facilities
• MANPOWER Instructors Instructional Administration and Supervisors Base Administration and Support	• OPERATION AND MAINTENANCE Equipment Facilities Pay and Allowances

Figure 38-4. Typical resource and cost factors.

Table 38-3. Representative instructional media suitability for elements of learning strategy.

LEARNING OBJECTIVES AND ELEMENTS OF LEARNING STRATEGY > / REPRESENTATIVE INSTRUCTIONAL MEDIA	ASSOCIATIONS & DISCRIMINATIONS			VERBAL CHAINS			MOTOR CHAINS			CLASSIFYING, RULE USING & PROBLEM SOLVING			PERCEPTUAL-MOTOR SKILLS			ATTITUDES, OPINIONS & MOTIVATIONS		
	PRESENTATION	PRACTICE	FEEDBACK	PRESENTATION	PRACTICE	FEEDBACK	PRESENTATION	PRACTICE	FEEDBACK	PRESENTATION	PRACTICE	FEEDBACK	PRESENTATION	PRACTICE	FEEDBACK	PRESENTATION	PRACTICE	FEEDBACK
CLASSROOM INSTRUCTOR																		
Lecturer	YES	NO	NO	YES	NO	NO	P	NO	NO	YES	P	P	NO	NO	NO	YES	P	P
Demonstrator	YES	NO	NO	YES	NO	NO	P	NO	NO	YES	P	P	YES	NO	NO	YES	P	P
Tutor/Coach	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Teaching Interview	YES	NO	NO	YES	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO	NO	YES	P	P
INSTRUCTIONAL AIDS																		
Overhead Projector	YES	P	P	YES	P	P	YES	P	P	YES	P	P	P	NO	NO	YES	P	P
35mm Slides	YES	P	P	YES	P	P	YES	P	P	YES	P	P	P	NO	NO	YES	P	P
Chalkboard	YES	NO	NO	YES	NO	NO	YES	NO	NO	YES	NO	NO	NO	NO	NO	YES	NO	NO
8mm Movie (silent loop)	YES	NO	NO	YES	NO	NO	YES	NO	NO	YES	NO	NO	YES	P	P	YES	NO	NO
MULTIMODAL MEDIA																		
Prenarrated Slides (with stop)	YES	YES	YES	YES	YES	YES	YES	YES	P	YES	YES	YES	YES	YES	P	YES	YES	P
Prenarrated Filmstrip	YES	P	P	YES	P	P	YES	P	P	YES	P	P	YES	P	P	YES	P	P
Slide/Workbook/Audio cassette	YES	YES	YES	YES	YES	YES	YES	P	P	YES	YES	YES	YES	P	P	YES	YES	YES
Movies (sound)	YES	P	P	YES	P	P	YES	P	P	YES	P	P	YES	P	P	YES	P	P
TV (cassette)	YES	P	P	YES	P	P	YES	NO	NO	YES	P	P	YES	P	P	YES	P	P
PRINT																		
Books	YES	P	P	YES	P	P	YES	P	P	YES	P	P	P	NO	NO	YES	P	P
Computer (words & numbers only)	YES	P	P	YES	P	P	YES	P	P	YES	P	P	NO	NO	NO	YES	P	P
Programmed Instruction Booklet	YES	YES	YES	YES	YES	YES	YES	P	P	YES	YES	YES	P	NO	NO	YES	YES	YES
Microfiche	YES	P	P	YES	P	P	YES	P	P	YES	P	P	P	NO	NO	YES	P	P
PEER																		
Role Playing	P	P	P	P	NO	NO	N/A	N/A	N/A	P	YES	YES	N/A	N/A	N/A	YES	YES	YES
Discussion Group	P	P	P	P	NO	NO	N/A	N/A	N/A	P	YES	YES	N/A	N/A	N/A	YES	YES	YES
Tutor/Coach	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
SIMULATION																		
Actual Equipment Trainer	NO	P	P	NO	NO	NO	YES	YES	YES	NO	YES	YES	P	P	P	N/A	YES	YES
Gaming	NO	P	P	NO	NO	NO	N/A	YES	YES	NO	YES	YES	N/A	N/A	N/A	N/A	YES	YES
Interactive Computer (plasma terminal)	YES	YES	YES	YES	YES	YES	YES	P	P	YES	YES	YES	N/A	N/A	N/A	YES	YES	YES
Case Study	NO	P	P	NO	NO	NO	NO	NO	NO	YES	YES	YES	NO	NO	NO	YES	YES	YES
ACTUAL END ITEMS	NO	P	P	NO	NO	NO	YES	YES	YES	NO	P	P	P	P	P	YES	YES	YES

CODE: **YES** – is effective
NO – is not effective
P – under certain circumstances, effective use is possible, or, there are inherent limitations in the effective use
N/A – use of the media is inappropriate

and workbooks, instructor guides, slides, tape recordings, charts, and case-study scenarios.

Before preparing new material, check the availability and suitability of existing publications and aids. Suitability should be based upon an analysis of the objectives in order to determine what knowledge and behaviors the student should gain through the use of the material. Commercial self-instructional materials are available on a wide variety of subjects. The other military services have also developed self-instructional materials, many of these in subject-areas that are common to the Air Force. Other publications, such as manuals, technical orders, and manufacturer's handbooks for specific equipment, should be reviewed for possible use. Some of these may need little or no supplemental guidance for use by the student; they are quite appropriate for instructional use if they are the same materials the student will use on the job. Often the use of adjunct programmed-instruction techniques can make these materials quite useful for instruction. Air Force and commercial self-instructional materials and other instructional publications and audiovisual packages can be identified through the use of military and commercial indexes, bibliographies, and catalogues.

When it is necessary to develop new materials, the objectives these materials must support and the students for whom they are being made must be kept in mind. Since the most effective instruction is student-centered, techniques consistent with the principles for effective learning must be used. The materials must be so constructed that the students will be attentive. Their attention can be ensured by requiring them to make specific responses to the presentation; these responses can involve requiring students to answer relevant questions, operate a piece of equipment, or make some other kind of observable, measurable behavior. The materials must move them in the direction of the criterial behavior and guide them toward mastery. By carefully planning the stimuli to which the students will be exposed, and by proper use of reinforcement theory, the developer can shape the desired behaviors.

The instructional materials produced by the developer should be edited for technical accuracy by subject-matter experts. This editing should not be restricted to a review of technical content, but should include such features as the adequate use of tools, appropriate safety precautions, adequate indications of supervision, and the following of major command policies. The materials should also be edited for composition. The editing should be concerned with the ability of the instructional materials to communicate. Do they use language which the learner understands? Are they free of unnecessary repetition and ambiguity?

Validating Instruction

Thus far in the instructional system development process, the objectives and criterial tests have been developed; appropriate methods of instruction and appropriate media have been selected; instructional content has been sequenced; and instructional materials which will most effectively support the learning process have been developed. Still, there is no assurance at this point that all this effort will result in effective instruction. It must be proven that students who have received this instruction will acquire the necessary job skills and knowledge. The test items which were developed in order to measure the objectives are the means to determine whether or not the instruction is effective. This process of proving the effectiveness of the instructional components, and then of the total system, is called validation. Each step in instructional system development is validated by checking student performance against the performance criteria.

Validation is a powerful tool for use in refining instruction. Use it. It is best not to wait till the complete instructional system is developed and then test it all at once. Rather, test portions of it as they are produced.

The system is developed unit by unit and is tested or validated on the basis of the objectives for each unit. This validation process validates the particular combination of instructional materials, media, and methods that was used. Instruction that cannot meet validation requirements may fail because any or all of these--materials, media, methods--were wrong choices or were not properly developed.

Ideally, the first step in the validation process, following the preparation of a small instructional unit, is to test its effectiveness on individual students who are representative of the students for whom the instruction is being developed. The students selected for the purpose of validation should fall within the range of aptitudes, prior knowledge, skills, and backgrounds of the typical input population. Preferably, those selected should fall within the upper range of aptitudes. If they have trouble learning the material, it would be too difficult for the less-capable students. Also, the student with higher ability may point out weak areas in instruction. Moreover, if the initial presentation were to be given to students scoring in the lower range of aptitudes, and they did well, it would be hard to assess the relative difficulty of the lesson. It is simpler to expand material to make instruction more effective, than it is to determine what material to leave out in order to achieve the optimum level and quality of instruction.

Conduct several individual tryouts before you make any significant technical changes. Then conduct a try-out on a group of students. The reason for trying out instruction on a group of students is to see how that part of the instructional system works under conditions approximating the actual classroom situation. So, the validation efforts should be expanded to groups of 6 to 10 students as soon as satisfactory results are obtained with individual tryouts.

The small-group tryouts should be continued until a total of 20 to 30 students have been through the instructional sequence. The students selected for this phase of validation should also represent the target population. The selections should include, insofar as possible, an even distribution of low, average, and high-aptitude students.

At this point in validation, time becomes a factor. It is not sufficient that students learn the material in an instructional sequence; they must also complete it within a reasonable period of time. Therefore, during small-group tryouts, the time needed by each student to complete an instructional segment should be tabulated along with the students' scores.

The final stage of the validation process is not usually conducted by the developers, but by the personnel who will have to operate the system. The length of the sequence will vary. It may be a portion of an instructional block, a complete block, or an entire course of instruction. Availability of time and resources will, to a great extent, dictate the scope of the instructional area undergoing a final operational tryout.

There are several reasons why it is desirable to conduct a complete tryout. First, though the small segments of instruction have proven successful, they have only been validated in an isolated environment. Now they must be evaluated as integral parts of the total system. Second, the analysis of the data gathered from this larger sample population will form a solid basis for final revision and refinement of the system. Third, it will provide an opportunity to work out administrative, equipment, facility, or other implementation problems and to update the course control documents as required.

Each of the three steps in the validation of instruction provides valuable information, so every effort to conduct them should be made. If the whole validation process can't be used, as much as possible of the process should be used. Still, there will be situations in which the students are not available until the course starts, and there is no practical way of getting substitutes for the students in order to conduct a realistic tryout. When this happpens, as much of the validation data as possible should be gathered from the students in the first few classes. If possible, a waiver on the course length should be obtained for these first few classes, so that some extra time may be available at the end of a unit of instruction to be used by the students in carefully critiquing that portion of the instruction.

The fourth step in the model calls for the developing and validating of instruction to be sure that the objectives of a course can be effectively and efficiently fulfilled. This involves the sequencing of teacher-learning activities in order to provide the best possible learning environment. The planning also includes the selection of the most appropriate instructional methodology, equipment, and aids to support these activities. The programming of equipment, facilities, manpower, and funds must be finalized so that such resources are available when required. Instructional materials are prepared, and, finally, all elements of the instructional system are tested and revised until they have been validated.

Description of the Process: Conduct and Evaluate Instruction (Step 5)

Conducting the Instruction

After the instruction has been developed and validated, it is ready to be used. Resources should be available by this time. The instructors, supervisors, and managers of instruction should be familiar with the instructional materials. They should also be familiar with their own roles and functions within the system.

Instructors must know how the system is intended to function and how they are to function within the system. This information should be provided in an instructor's guide. Management must ensure that instructors study and apply these instructor's guides. All personnel concerned must understand that arbitrary changes in the validated instruction cannot be made without endangering the effectiveness of the instruction.

There may be a need for instructor training (or retraining). Instructors faced with the task of using new teaching techniques may feel (and may be) inadequate. Therefore, course administrators must be sure that instructors receive instruction on the use of new concepts and techniques, as well as on the reason for their use.

Management must also plan for the maintenance of the system. Training literature, expendable supplies and tools must be there when needed by the students. Training devices must be kept in good condition, and a proper level of spares should be available. If the organization conducting the instruction does not have its own audiovisual equipment, it will have to schedule the use of loaned equipment. This kind of planning is always important for effective instruction, but it is critical when self-paced, individualized instruction is involved.

For a variety of reasons, instruction will need to be updated periodically. The revision of instructional materials calls for the same careful planning, development, and validation as did the development of the original instructional materials. Management must plan for the availability of adequate, qualified personnel to support this effort.

A self-paced instructional system presents management with a number of special challenges. The problem of keeping track of the status of each student--what training each student has successfully completed, what her/his special needs are, and what equipment is available to work on next--can be a big one. If there are many students involved and (or) the scheduling is complex (for example, in flying training, where scheduling is difficult since weather is uncertain), you may need

a computer for the scheduling and recordkeeping.

Of course, it does no good to develop quality instructional materials and systems unless they are used properly, and unless the skills and knowledge learned by students are used. This problem involves the management of the students who are selected to get the instruction. If the students sent to the course do not have the prerequisites, not only is the students' time wasted, but the whole instructional system design effort can be destroyed. The ISD effort is also wasted if the people who are trained are not given the chance to use what they have learned.

Evaluating the Instructional System

To be sure that the students learn what they need to know, once instruction is started it must be continually evaluated. This evaluation examines both the conduct of the instruction and how well the graduates do on the job. To avoid any conscious or unconscious biasing of the findings, the personnel who conduct the evaluation should not be the same people or organization which designed, implemented or operate the system; this evaluation should be conducted by someone else. The ISD model shows that the process is a complete cycle involving feedback. This feedback is the means for ensuring continuing quality in graduate performance. If evaluation of the instruction shows a need for change, depending upon what that change is, the cycle, or some part of it, is repeated. Thus, if it is found that there is new equipment which the graduates can't handle, Step 1 should be repeated in order to identify and analyze the new job tasks; then Step 2 should be carried out again, in order to determine the instruction needed, etc. If it is found that the graduates have forgotten important information, Step 4 should be repeated in order to redesign the instruction, so that it will be retained longer. Other findings might indicate a need to alter one or more objectives (Step 3).

Despite the care with which the instructional program has been developed, it is still possible that the graduate's performance may not meet the job requirements. There may be a number of reasons for this. In the time between when the job performance requirements were determined and when the graduate arrived at the job, some job performance requirements may have changed. Or, the graduates may have forgotten some of what they learned. It is also possible that there are weaknesses in the instructional program, that the instruction is not being conducted as planned, or that students who do not have the prerequisites are taking the instruction. Through field evaluation and internal evaluation, such problems can be identified.

Internal Evaluation

The results of internal evaluation do not prove the instructional system is adequate (or inadequate), but they do point to some of the system problems and suggest areas for improvements.

An internal evaluation must start with an analysis of the instructional system control documents. The objective is to see if discrepancies exist between the instructional system as outlined in the control documents and what occurs during instructional system operation.

Internal evaluation should include checks of existing training facilities, equipment, tools, and supplies to be sure that they meet the needs of the instructional system. In addition, support facilities and services should be evaluated to determine their adequacy, condition, and maintenance.

Visits to instructional facilities for evaluative purposes should be long enough and often enough to assure the observation of representative teaching. Trainers, instructional media, and aids specified for use in the facilities should be checked for condition, operation, and appropriateness. Instructional literature should be checked for availability and quality.

The instructor's activities should be the same as what is called for in the plan of instruction (or syllabus) and in the instructor's guides. Instructors must show the proper use of instructional system technology. Instructor's records must be current, and must show the amounts of in-service and special training completed. The instructor rating sheets should be completed by the instructor-supervisors; where they show instructor weaknesses, they should also show suitable corrective actions.

This is an important source of information as to whether the system is functioning effectively.

Field Evaluation

The Internal Evaluation of all parts of the instructional system provides a basis for determining system effectiveness. But, even if internal evaluation shows no fault in planning, developing, or conducting the instruction, it is not guaranteed that the graduates will perform satisfactorily on the job. Field evaluation is also necessary. The purpose of field evaluation is to find out if recent graduates can do their assigned tasks to the level of proficiency specified in the applicable training standard. If the graduates do not need what they were taught, or do need instruction they didn't receive, this information must be fed back to the instructional system designers; there is a need to change the instruction. If the graduates cannot do some tasks sufficiently well, there may also be a need to change instruction. Perhaps there wasn't enough practice during instruction to ensure retention.

The matter of retention of instruction requires a special comment. In analyzing field-evaluation findings, indications that the graduates have forgotten some of what they were taught should be carefully investigated. The instruction they were given could be at fault, but there are

several other possible causes that relate to job conditions which should be assessed. The behaviors produced during instruction must be used in the job situation or else they will disappear. These behaviors will not be used on the job if it is unrewarding or punishing to the graduate to continue to use them. A few examples will indicate some of the many possible situations:

-- The graduate is not permitted to apply on the job what s/he learned during instruction.

-- Some of the graduate's fellow workers, who have not received the instruction s/he got, feel threatened. To preserve their good will, s/he stops applying what was taught.

-- Graduates who learned how to do the task properly find that on the job others, who do a "halfway" job with much less effort, receive the same "rewards" that they do.

So, to properly evaluate the indications that the graduates haven't retained instruction, one must also know what happened to them after they completed their instruction. Otherwise it is possible to mistakenly invest time, equipment, and money in "beefing-up" instruction that is not at fault.

A field evaluation must be carefully designed and conducted to ensure the collection of accurate and valid data. The data for the evaluation may be obtained through the use of mailed questionnaires sent to the supervisor, to the graduate, or to both. It may be obtained through field visits during which the graduate's performance is observed; or the graduate and her/his supervisor may be interviewed; or both observation and interview may be used together. Another alternative is the controlled job-performance evaluation in which the graduate's performance over a specific period of time is observed, evaluated, and reported by her/his supervisor.

Questionnaires are the least expensive procedure for field evaluation and may be used to collect large samples of information about graduates. However, questionnaires may not be the most valid form of evaluation. The validity of the data gained through the use of the mailed questionnaire depends upon how well it is prepared and distributed. Questionnaires should be piloted before general use is made of them in order to be sure that those who received them understand the questions in the same way that the designer of the questionnaire does.

The main portion of the questionnaire consists of a list of task and knowledge statements, either extracted from the instructional standard which serves as the primary control document for the instruction being evaluated or paraphrased from this document. The graduates' supervisors can be asked to rate them on their ability to do each task listed in the questionnaire. A similar type of questionnaire can be sent to the graduates, asking them to indicate how well they think the instruction equippped them to meet the needs of their job. They could also be asked to check those tasks which they do not do.

For full use of the questionnaire technique of evaluation, supplemental "information-seeking" questions might be added. Such questions may ask the graduates to estimate the amount of time they spend on the different tasks or duties within their Air Force Specialty (AFS). Other questions may ask about items of equipment, materials, or procedures used by the graduates. An open-ended question could be included, asking for suggestions as to how instruction might be improved.

However field evaluation data is gathered, it is essential that a representative sampling of the total number of graduates be used. There may be variances in job requirements and in the use of graduates, depending upon the function of the organization to which the graduate is assigned, the geographical location, etc. The sample should allow for these possible sources of variation.

Field evaluation visits are made by personnel who are normally engaged in instructional activities. They are sent to visit a representative sample of graduates approximately 3 to 6 months after these graduates have been assigned to their jobs. The purpose of these visits is to obtain first-hand information concerning graduate assignment, utilization, and proficiency on the job, and to validate information gained from questionnaires. Data is gathered through observation and interviews with both the graduates and with their immediate supervisors. The main purpose is to find out how proficient the graduates are. But the evaluator also wants to know how the graduates' skills are being used and how well they are progressing through on-the-job training. A list of supplemental questions, similar to those used in a mailed questionnaire, should be used as a guide when an interview is conducted with a graduate's supervisor. Notes should be taken on the answers to significant questions, in addition to specific or implied comments.

Summary

To ensure an effectively operating instructional system, it is not only necessary to develop validated, job-referenced instruction, but there must also be planning and preparation for the implementation and maintenance of the instructional system. This will require training for instructors in their new roles, and orientation for supervisors and managers in the supportive actions which they must provide. When the system becomes operational, it is necessary to conduct both internal and field evaluations. The evidence collected during these evaluations must be examined to determine if the graduates are, in fact, capable of satisfying job-performance requirements. This information will provide the feedback to the instructional system personnel.

Now that the description of the ISD process has been presented, it may aid the reader's understanding if a few of the more significant ways in which this process differs from the more tradi-

tional ways of designing instruction are pointed out:

-- The systems approach defines a process which **focuses upon the job** that is ultimately to be performed and **upon the individual** who is to learn to perform that job. Traditional approaches, by contrast, focus upon **conventional subject-matter blocks** that tend to be more of the "school catalog" variety and are, generally, only approximately pertinent to what the student will be doing later (Russel E. Schulz, et. al., "On-Line Authority Aids for Instructional Design," TR 387, U.S. Army Research Institute, July 1979, pp. 1 and 2).

-- ISD calls for analyzing and documenting job performance requirements and for developing explicit training objectives. It calls for these objectives to be stated in terms of expected performance (behavior), conditions under which that behavior is to be performed, and the standards to which it is to be performed. Training or objectives not necessary for job performance are eliminated. Conventional instruction tries to do the same thing, but in a less systematic, less scientific way--with the result that training objectives are often fuzzy and ambiguous. Also, objectives and training are often included which are not necessary for job performance.

-- With ISD, accomplishment of the behaviorally-stated objectives is the goal. Where practical, time is the variable and the student progresses as s/he demonstrates mastery of the objectives. With conventional instruction, time is usually fixed. All students get the same quantity of instruction whether or not they need it. And student achievement is the variable.

-- In ISD, performance tests are developed along with the objectives, and then the lesson content is developed. The tests then serve as a check on the instruction. In conventional instruction, lesson content is selected and written and then tests are written which are based upon this lesson content. This may result in students who do well on the tests but perform poorly on the job.

-- With ISD, student performance is criterion referenced. The student is measured against specific standards--how well s/he accomplishes the objectives. In conventional instruction, norm-referenced measurement is usually employed. That is, students are measured in relation to how other students perform.

-- Under the ISD process, instruction is validated on the target population prior to implementation. With conventional instruction, this is rarely done. Instruction is implemented without validation, and modification awaits feedback from graduate evaluation. Often this process takes several years.

HOW USAF IS APPLYING THE ISD PROCESS

The Scope of USAF Training

The Air Training Command (ATC) is the Air Force command which provides most of the formal training for the Air Force. The courses ATC provides cover a wide range of subject matter, including:

-- Basic training for officers and enlisted persons.

-- Initial-skills training (everyone in the Air Force is a specialist). These courses range from heavily performance-oriented equipment maintenance and operator courses, to courses that are mostly cognitive. They relate to technical training, health, education, and flight training.

-- Advanced training to upgrade skills and knowledge.

-- Lateral training to extend skills and knowledge to related equipment.

-- Professional military education (courses in management, leadership, etc.).

-- University-level educational programs.

-- Extension Courses.

ATC also conducts on-the-job training for its own personnel. The other commands become involved in training, too. The Air Force Regulation on Instructional System Development has directed, as Air Force Policy, that the ISD processes will be used in developing all of these types of training and educational courses.

The Air Force provides support to those involved with the application of ISD in a variety of forms. **Air Force Manual AFM 50-2, Instructional System Development,** presents an instructional development model for developing and conducting efficient and cost-effective instructional systems. This is the model that was summarized earlier in this chapter. **AFM 50-2** also includes a discussion of some of the special problems which are involved in trying to apply the ISD process to the design and evaluation of instruction for technical training, flight training, training in support of new weapon/support systems, knowledge and attitudes, and on-the-job training.

Air Force Pamphlet AFP 50-58, Handbook for Designers of Instructional Systems, provides guidance in applying the process described in **AFM 50-2,** and some of the related instructional technology. It describes the entire development process in detail. It is a handbook which provides suggested procedures and techniques. The reader must decide which suggestions will be applicable and helpful to her/his situation. Volume I provides an overview of the use of the handbook and of the process of instructional system development, a version of the ISD model that is expanded to the third level of detail, an explanation of the terms important to ISD personnel, and an example of the application of the ISD process in a case-history format. Volumes II through V provide guidance on how to analyze system requirements; define education/training requirements; develop objectives and tests; plan, develop and validate instruction; and conduct and evaluate instruction. The sixth volume does not describe a part of the ISD process; rather, it presents the basic concepts of programmed instruction and describes a variety of

programming techniques. Volume VI is a part of the handbook because programmed instruction is a student-centered method of instruction that is compatible with a systems approach.

An instructional-technology film series has been developed. It includes an introductory film on the ISD process, and films on system analysis, on the development and use of occupational survey data, on criterial objectives, on criterion-referenced testing, on individualized instruction, on the changing role of the instructor, on selecting instructional media, on performance testing, and on validation and evaluation. The films in the series are intended to introduce concepts and to favorably influence attitudes. They are not designed to develop the in-depth knowledge and skills needed to apply the concepts.

The Air Force also publishes a periodic newsletter, "Development of Instructional Technology" ("DO IT"). Its purpose is to promote an exchange of information on the latest developments in training technology and to communicate the general state of the art in training technology to the field at large. It is a means for sharing ideas and for promoting communication between those who are dealing with a common problem.

Information alone usually is not sufficient; training is also needed. So, the Air Force provides three courses:

1. The "Instructional System Designer" course is a 4-week resident course designed for the individuals who design courses for training programs. This course trains an individual to perform all of the ISD activities, from task analysis through the design and validation of instructional materials.
2. "Development and Management of Instructional Systems" is a 5-day course for training the managers and supervisors of the personnel who develop instructional systems.
3. "Staff Orientation-Instructional System Development" is a 1-day course for staff-level managers who support the ISD effort but are not directly responsible for the resulting training.

Understanding and support by high-level management is critical to the successful application of the ISD process. For these people, the Air Training Command prepared an "ISD Executive Summary for Commanders and Managers." Some of the other major commands have developed similar pamphlets. The purpose of these pamphlets is to acquaint the commanders and managers with the essence of the ISD process, to indicate how it can help them, and to explain what they must do (and not do) to aid the process.

Finally, Air Training Command maintains an Advisory Service on instructional systems and instructional technology for the Air Force. The mission of the Advisory Service is to keep those who need to know aware of the state-of-the-art in instructional technology and to provide advice regarding the application of the instructional-system-development process. This includes the identification of relevant materials and of similar systems that already exist.

Extent of Application

An Air Force regulation directs the use of the ISD process when new instructional systems are developed, and when major changes are made in existing educational and training programs. In the Air Training Command, the ISD process has been applied to the design of:

- Some of the professional military education courses.
- Training for flying personnel.
- Maintenance training for new weapon/support systems, such as the E-34 aircraft and the F-16 aircraft.
- More than 760 technical-training courses.

Other major commands are also applying ISD. Most of their efforts have involved operational training for flying personnel.

Benefits Acquired

Where the ISD process has been conscientiously applied, the results have been:

- More effective use of instructional time.
- Generally, reduced instructional time (sometimes, there has been a need to increase instructional time.)
- Identification and elimination of unneeded instruction.
- Training which better meets the needs of the operating orgainzations.
- Provision of a better basis for selecting and designing simulators and trainers. (Some simulators and trainers, especially those used for training flying personnel, are very expensive, so, if such training devices are ineffective or unneeded, they can be very costly blunders.)

Success Stories

By 1978, the ISD process had been applied to 760 resident technical-training courses taught by the Air Training Command (174 of these were shortened and 56 were lengthened). The net result was a savings of 227 instructional weeks. (Not all of this savings was the result of applying ISD; part of it came from a change in training philosophy which caused a reduction in the amount of theory taught in some apprentice-level maintenance courses.)

The Aircraft Electrical Repairman Course trains airmen in the skills and knowledge required to maintain electrical systems on all types of aircraft. When this course was taught as a conventional, group-paced course, the course length was 80 days. When it was redesigned as a self-paced instructional system, the average instructional time required by the first 490 students was only 69 days. More important than the savings in time is the fact that, in the self-paced version of the

course, each student achieves each criterion objective. By contrast, the group-paced, conventional instruction often resulted in only a partial achievement of the objectives by most of the students.

The Maintenance-Analysis Technician Course is an advance course in inferential statistics for preparing senior noncommissioned officers and their civilian counterparts to analyze maintenance data. When it was redesigned as an instructional system, it became a totally self-paced course in which the student receives instruction from video tapes and programmed workbooks, and uses electronic calculators to perform the analytical functions. In this arrangement, the student can spend as many hours a day and as many days a week in study as s/he wishes. The average student takes 21 days to complete what had been a 35-day course.

The F-4 is a fighter aircraft that has a 2-man crew consisting of a pilot and a weapons-system operator. When the course to train this team was systemized, the analysis of mission requirements (steps 1 and 2) led to the deletion of 10 training days and 14 flying hours for each crew member. This resulted in an annual savings of over $7.5 million.

One of the major commands required that annual refresher training be given to their aircraft-maintenance personnel on how to treat and remove aircraft corrosion. They assigned their ISD team to apply ISD to this training. The documentation the team developed (steps 1 and 2) showed that this training was not needed, because when the maintenance personnel spotted corrosion, they had to call in a Corrosion Control Specialist to treat it. By eliminating this training for the many personnel who did not need it, the Command saved about 30,000 student man-hours per year.

Problem Areas

To provide a balanced picture, it must be pointed out that there have been - and are - some problems in the Air Force's efforts to convert to the ISD process. It may be instructive to briefly examine some of them.

Given a problem involving the production output of his people, a manager sometimes prejudges the solution to be training, and directs the establishment of a course. (Earlier, we described how the manager should have handled this situation.)

A manager sometimes imposes unrealistic suspenses for completion of events in the instructional development of a course, or abruptly changes the planned completion date. The manager should require the preparation of an ISD plan with a time-phasing chart, and a rationale for the amount of time proposed. The development of an instructional system is a comparatively slow process, though there are trade-off options in the development process which can make a substantial difference in the development time in return for sacrificing some quality. Imposing a short suspense may seem like good management, but if it is unrealisitic and forces the developer(s) to by-pass essential parts of the process, it will be counter-productive.

More often than they should be, some parts of the ISD process are by-passed - usually because the developer feels pressed for time. These include:

- Use of the survey test.
- Validating instructional materials and instructional aids.
- Field evaluation of graduates.

When the survey test is not used, the instructional system developer is deprived of information which could have important consequences for the design of instruction. When validation is by-passed, the effectiveness of instruction cannot be determined until evaluation takes place, and that is too late for the students involved. Without field evaluation, the developers do not know how well their training equipped the graduates to do their jobs.

Too often there is a lack of documentation. Not only does this make the ISD effort suspect, it also lessens the potential value of the iterative part of the process.

Because multiple-choice tests are easier to administer and take less time than do performance tests, sometimes they are used when they should not be. The test item should measure the behavior the instruction is to shape. If it doesn't the testing effort is wasted. For example, if the objective is for the student to be able to parallel-park a car, multiple-choice questions cannot determine whether or not the student has met the objective.

Experience has shown that when "experts" apply the ISD process, they get very good results. But it is hard for the Air Force to get ISD experts in the quantity needed. This is so because most military personnel are rotated to new assignments every 3 to 4 years; and because the bulk of the ISD effort has to be borne by classroom instructors, who are subject-matter specialists, but who have had minimal training and experience in ISD. The Air Force does have a career field for Instructional System Specialist/Technician. However, the use of these specialists is quite limited, because for many organizations the choice is either an instructional systems developer who knows little about the subject matter, or a subject-matter specialist who has a limited knowledge of ISD. In most cases, Air Force training organizations seem to prefer to work with the subject-matter specialists and teach them what they need to know about ISD in order to perform their functions. In some cases an ISD team is formed, usually with a mix of subject-matter specialists and instructional systems designers.[6] This is probably the best solution to the problem. But for many organizations the limited manpower which is authorized will not permit the luxury of establishing an ISD team. Another possible solution to the problem is to simplify the process by devising better authoring aids and decision-tables.

PROSPECTS FOR THE FUTURE

The period of transition to the ISD process in the Air Force has been a difficult one for several reasons. Despite all this, the process has been demonstrated to be effective in a wide variety of situations.

There remain many obstacles to achieving the goal of meaningful, across-the-board application of the ISD process. Some of the obstacles will be easier to overcome than others. But the economic pressures are strong and the present leadership of the Air Force is determined; and at least as long as these two motivators are present, there is sure to be a continued growth in the applications of ISD - growth in the number of applications and growth in the quality of the applications.

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[6] In the Air Training Command, a different type of "team" concept is used. Because the mission of this large organization is training, the ISD function is integrated into the command structure. Therefore the Occupational Measurement Center gathers the job-performance requirements for most of the Air Force specialty areas. The functional managers in the Headquarters define the major constraints. The Plans and Requirements Division at each Technical Training Center determines the training requirements. The Training Branches have specialists who define the objectives, develop the criterion tests, select the instructional methods and media, and prepare the plan of instruction (syllabus). The instructors, who are the subject-matter specialists, develop and validate the instructional materials. And the Evaluation Division evaluates the performance of the graduates.